AMENDMENTS TO THE CLAIMS

The claims in this listing will replace all prior versions, and listings, of claims in the application.

20. (Previously Presented) A reception apparatus comprising:

a generator that generates a sampling timing at a predetermined sampling rate;

a first estimator that estimates a first synchronization timing of a received signal at the sampling timing;

a switch that shifts a phase of the sampling timing by 180°;

a second estimator that estimates a second synchronization timing of the received signal at a sampling timing phase shifted from the sampling timing of the first synchronization timing by 180°; and

a third estimator that estimates a third synchronization timing, which is a definitive synchronization timing of the received signal, from the first synchronization timing and the second synchronization timing,

wherein the switch shifts the phase of the sampling timing at a time interval longer than a symbol duration.

21. (Previously Presented) A reception apparatus comprising:

a generator that generates a sampling timing at a sampling rate corresponding to a reference clock signal;

a first estimator that estimates a first synchronization timing of a received signal at the sampling timing;

a switch that shifts a phase of the sampling timing by inverting a polarity of the reference clock signal;

a second estimator that estimates a second synchronization timing of the received signal at the sampling timing phase-shifted from the sampling timing of the first synchronization timing; and

a third estimator that estimates a third synchronization timing, which is a definitive synchronization timing of the received signal, based upon the first synchronization timing and the second synchronization timing,

wherein the switch inverts the polarity of the reference clock signal at a time interval longer than a symbol duration.

22. (Previously Presented) The reception apparatus according to claim 20, wherein the third estimator further estimates the third synchronization timing at a time resolution twice the time resolution of said predetermined sampling rate, based on reliability information indicating a likelihood of the first synchronization timing and the second synchronization timing.

23. (Previously Presented) The reception apparatus according to claim 20, wherein the third estimator further chooses the synchronization timing of higher reliability as the third synchronization timing, based on reliability information indicating a likelihood of the first synchronization timing and the second synchronization timing.

24. (Previously Presented) The reception apparatus according to claim 20, wherein the third estimator further estimates the third synchronization timing through interpolation of the first synchronization timing and the second synchronization timing, based on reliability information indicating a likelihood of the first synchronization timing and the second synchronization timing.

25. (Previously Presented) The reception apparatus according to claim 20, further comprising a controller that controls a period of an operation mode in which the switch shifts the phase of the sampling timing.

26. (Previously Presented) The reception apparatus according to claim 25, wherein the switch further fixes the phase of the sampling timing at a phase corresponding, during a mode other than the operation mode, to the third synchronization timing estimated during an earlier operation mode.

27. (Previously Presented) The reception apparatus according to claim 20, further comprising a transmitter that transmits transmission data using a sampling timing corresponding to the third synchronization timing.

28. (Previously Presented) A reception apparatus comprising:

a receiver that samples a received signal at a predetermined sampling timing;

an operator that determines a correlation between the received signal and a known signal sequence through a vector operation;

a first estimator that estimates a first synchronization timing of the received signal based on an operation result of said operator;

an operation value ratio table that stores operation value ratios and a plurality of associated short times, said operation value ratios indicating ratios between a plurality of correlations determined at sampling timings shifted from ideal sampling timings by the short times; and

a second estimator that reads said operation value ratio table and detects an operation value ratio closest to a ratio between the correlations corresponding to the first synchronization timing, and estimates a timing shifted from the first synchronization timing by a short time corresponding to the detected operation value ratio as the second synchronization timing.

29. (Previously Presented) The reception apparatus according to claim 28, further comprising:

a propagation path estimator that estimates a propagation path condition; and

an updater that updates the operation value ratio table based on the propagation path condition.

30. (Previously Presented) The reception apparatus according to claim 28, further comprising:

a tap coefficient table that stores tap coefficients and a plurality of associated short times, the tap coefficients corresponding to sampling timings shifted from ideal sampling timings by the short times; and

a canceler that cancels inter symbol interference from the received signal using tap coefficient corresponding to a short time indicating a shift between the first synchronization timing and the second synchronization timing among the tap coefficients in said tap coefficient table.

31. (Previously Presented) A reception apparatus comprising:

a receiver that samples a received signal at a predetermined sampling timing;

a tap coefficient table that stores tap coefficients and a plurality of associated short times, the tap coefficients corresponding to sampling timings shifted from ideal sampling timings by the short times;

a canceler that cancels inter symbol interference from the received signal using the tap coefficients in said tap coefficient table;

an operator that determines correlation between signals having inter symbol interference removed and corresponding to the tap coefficients respectively, and a known signal sequence; and

an estimator that detects a tap coefficient that yields a maximum operation result in said operator and estimates a timing shifted from the predetermined sampling timing by a short time corresponding to the detected tap coefficient as a synchronization timing of the received signal.

32. (Previously Presented) The reception apparatus according to claim 31, further comprising a demodulator that demodulates a signal having inter symbol interference removed and corresponding to the tap coefficient detected by the estimator.

33. (Previously Presented) A reception method comprising:

generating a sampling timing at a predetermined sampling rate;

estimating a first synchronization timing of a received signal at the sampling timing;

shifting a phase of the sampling timing by 180° at a time interval longer than a symbol duration;

estimating a second synchronization timing of the received signal at a sampling timing phase shifted from the sampling timing of the first synchronization timing by 180°; and

estimating a third synchronization timing, which is a definitive synchronization timing of the receiving signal, from the first synchronization timing and the second synchronization timing.

34. (Previously Presented) A reception method comprising:

sampling a received signal at a predetermined sampling timing;

determining a correlation between the received signal and a known signal sequence through vector operation;

estimating a first synchronization timing of the received signal based on a vector operation result;

obtaining, from an operation value ratio table that stores operation value ratios and a plurality of associated short times, the operation value ratios indicating ratios between a plurality of correlations determined at sampling timings shifted from ideal sampling timings by the short times, and detecting an operation value ratio closest to a ratio between the correlations corresponding to the first synchronization timing; and

detecting a timing shifted from the first synchronization timing by a short time corresponding to the detected operation value ratio as a second synchronization timing.

35. (Previously Presented) A reception method comprising:

sampling a received signal at a predetermined sampling timing;

canceling inter symbol interference from the received signal using tap coefficients in a tap coefficient table which stores tap coefficients and a plurality of associated short times, the tap coefficients corresponding to sampling timings shifted from ideal sampling timings by the short times;

determining a correlation, through vector operation, between signals having inter symbol interference removed and corresponding to the tap coefficients respectively, and the known signal sequence;

detecting a tap coefficient that gives a maximum vector operation result; and

estimating a timing shifted from the predetermined sampling timing by a short time corresponding to the detected tap coefficient as a synchronization timing of the received signal.

36. (Currently Amended) A reception apparatus comprising:

a receiver that samples a received signal at predetermined sampling ~~timings~~ intervals to obtain sample timings;

an operator that determines a correlation at each sample timing ~~of said predetermined sampling timings~~ through a vector operation using a sampling result of said receiver and a known signal sequence;

a first estimator that estimates a ~~first~~ sample timing corresponding to a largest correlation of the determined correlations as a low-accuracy synchronization timing of the received signal ~~based on an operation result of said operator~~;

an operation value ratio table that ~~stores~~ associates an operation value ~~ratios and a plurality of associated~~ ratio with a short ~~times~~ time, said operation value ~~ratios~~ ratio indicating ~~ratios~~ a ratio between two correlations corresponding to ~~every two~~ a pair of neighboring sample timings ~~in a plurality of sampling timings~~ including ~~timings~~ a sample timing shifted from an ideal synchronization timing by ~~short times~~ the short time, said short time being shorter than a sample interval of the predetermined sampling intervals; and

a second estimator that reads said operation value ratio table and detects an operation value ratio closest to a ratio between ~~the~~ correlations corresponding to the ~~first~~ low-accuracy synchronization timing and a sample timing next to the ~~first~~ low-accuracy synchronization timing, and estimates a timing shifted from the ~~first~~ low-accuracy synchronization timing by a short time corresponding to the detected operation value ratio as a ~~second~~ high-accuracy synchronization timing.

37. (Currently Amended) A reception method comprising:

sampling a signal including a known signal sequence at predetermined sampling ~~timings~~ intervals to obtain sample timings;

determining a correlation at each sample timing ~~of said predetermined sampling timings~~ through a vector operation using a sampling result and a known signal sequence;

estimating a ~~first~~ sample timing corresponding to a largest correlation of the determined correlations as a low-accuracy synchronization timing of a received signal ~~based on a vector operation result~~;

reading ~~a~~ an operation value ratio table that ~~stores~~ associates an operation value ~~ratios and a plurality of associated~~ ratio with a short ~~times~~ time, said operation value ~~ratios~~ ratio indicating ~~ratios~~ a ratio between two correlations corresponding to ~~every two~~ a pair of neighboring sample timings ~~in a plurality of sampling timings~~ including ~~timings~~ a sample timing shifted from an ideal synchronization ~~timings~~ timing by the short ~~times~~ time, said short time being shorter than a sample interval of the predetermined sampling intervals;

~~and~~ detecting an operation value ratio closest to a ratio between ~~the~~ correlations corresponding to the ~~first~~ low-accuracy synchronization timing and a sample timing next to the ~~first~~ low-accuracy synchronization timing; and

~~detecting~~ estimating a timing shifted from the ~~first~~ low-accuracy synchronization timing by a short time corresponding to the detected operation value ratio as a ~~second~~ high-accuracy synchronization timing.